012363953 **Image available**
WPI Acc No: 1999-170060/**199915**
XRPX Acc No: N99-124100

Displacement measuring apparatus for rotary encoder, linear encoder - has movable scale whose light receiving position is adjusted according to output signal of light receiving elements

Patent Assignee: CANON KK (CANO)
Number of Countries: 001 Number of Patents: 001
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
JP 11023324	A	19990129	JP 97190518	A	19970630	199915	B

Priority Applications (No Type Date): JP 97190518 A 19970630
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
JP 11023324	A		13	G01D-005/38	

Abstract (Basic): JP 11023324 A

NOVELTY - The wavelength divided light beam is received by light receiving element (4a-4c). The incidence position of light beam on the movable optical scale is adjusted according to signal output from light receiving elements. The relative displacement between both scales is measured based on the signal output from the light receiving elements.

DETAILED DESCRIPTION - The light beam from a flicker gun (1) is projected on a fixed optical scale (2) and a movable optical scale (3), sequentially. The wavelength division of projected light beam is carried out by V-shaped grooves (30b) in the optical scales.

USE - For rotary encoder, linear encoder used in FD actuator, printer, NC machine tool, computer. For speed detection in stainless steel motor of VTR, rotary drum.

ADVANTAGE - Improves accuracy of displacement measurement by adjusting level of output signal of light receiving element. Enables precised detection of displacement information on moving body.

DESCRIPTION OF DRAWING(S) - The figure shows principal outline part of displacement measuring apparatus. (1) Flicker gun; (2) Fixed optical scale; (3) Movable optical scale; (4a-4c) Light receiving elements; (30b) V-shaped grooves.

Dwg.1/18

Title Terms: DISPLACEMENT; MEASURE; APPARATUS; ROTATING; ENCODE; LINEAR; ENCODE; MOVE; SCALE; LIGHT; RECEIVE; POSITION; ADJUST; ACCORD; OUTPUT; SIGNAL; LIGHT; RECEIVE; ELEMENT
Derwent Class: S02
International Patent Class (Main): G01D-005/38
International Patent Class (Additional): G01B-011/00; G01D-005/34; G01D-005/36
File Segment: EPI

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平11－23324

(43)公開日　平成11年(1999)１月29日

(51)Int.Cl.⁶	識別記号	ＦＩ	
Ｇ０１Ｄ　5/38		Ｇ０１Ｄ　5/38	Ａ
Ｇ０１Ｂ　11/00		Ｇ０１Ｂ　11/00	Ｇ
			Ｆ
Ｇ０１Ｄ　5/34		Ｇ０１Ｄ　5/36	Ｓ
5/36			Ｔ

審査請求　未請求　請求項の数６　ＦＤ　（全 13 頁）　最終頁に続く

(21)出願番号　特願平9－190518

(22)出願日　平成９年(1997)６月30日

(71)出願人　000001007
キヤノン株式会社
東京都大田区下丸子３丁目30番２号

(72)発明者　井垣　正彦
東京都大田区下丸子３丁目30番２号　キヤノン株式会社内

(72)発明者　高山　学
東京都大田区下丸子３丁目30番２号　キヤノン株式会社内

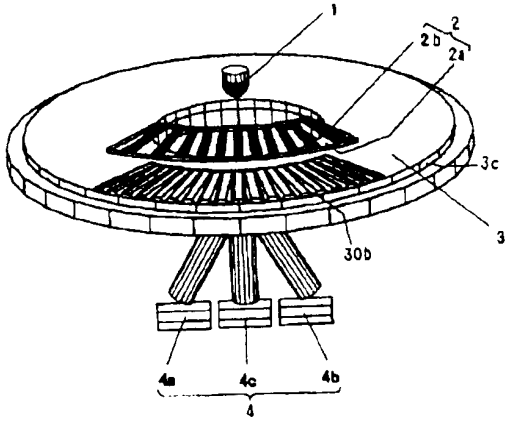
(74)代理人　弁理士　高梨　幸雄

(54)【発明の名称】　変位情報測定装置

(57)【要約】

【課題】　波面分割作用をする光学スケールを用いて変位物体の変位情報を高精度に検出することができる変位情報測定装置を得ること。

【解決手段】　第１，第２光学スケールのうち少なくとも一方に波長分割作用をするスケール部を設け、光照射手段からの光束を該第１，第２光学スケールに順次入射させ、該第１，第２光学スケールを介した後に複数に分割した光束を各々複数の受光素子を有する受光手段で受光し、該受光手段からの信号を利用して該第１，第２スケールとの相対的な変位情報を求める変位情報測定装置において調整手段によって該光照射手段からの光束の該第１，第２光学スケール面上への入射位置を変えて該受光手段の複数の受光素子で得られる信号の強度バランスを調整していること。



ルを用いた場合、3つの受光素子で検出される信号が、コンパレートレベルを設定するために必要な所定の比で検出されず信頼性の高い2値化信号を得ることができないという問題があった。

【0009】本発明は、基板面に例えばV溝を形成し、入射光束を波面分割するようにした光学スケールに光照射手段から光束を入射させ、該光学スケールで波面分割した複数の光束を各々、複数の受光素子で受光し、該複数の受光素子からの信号を用いて変位情報を求める際、光照射手段からの光束の光学スケールへの入射位置を変位させ、複数の受光素子からの出力信号レベルを調整することによって信頼性の良い2値化信号が得られ、高精度な変位情報が得られる変位情報測定装置の提供を目的とする。

【0010】

【課題を解決するための手段】本発明の変位情報測定装置は、(1-1) 第1，第2光学スケールのうち少なくとも一方に波長分割作用をするスケール部を設け、光照射手段からの光束を該第1，第2光学スケールに順次入射させ、該第1，第2光学スケールを介した後に複数に分割した光束を各々複数の受光素子を有する受光手段で受光し、該受光手段からの信号を利用して該第1，第2スケールとの相対的な変位情報を求める変位情報測定装置において調整手段によって該光照射手段からの光束の該第1，第2光学スケール面上への入射位置を変えて該受光手段の複数の受光素子で得られる信号の強度バランスを調整していることを特徴としている。

【0011】(1-2) 筐体内に設けた光照射手段からの光束を波長分割作用をするスケール部を設けた光学スケールの第1領域に入射させ、次いで該光学スケールの第2領域に再入射させ、該第2領域から射出する複数の光束を各々複数の受光素子を有する受光手段で受光し、該受光手段からの信号を利用して該筐体と該光学スケールとの相対的な変位情報を求める変位情報測定装置において調整手段によって該光照射手段からの光束の該光学スケール面上への入射位置を変えて該受光手段の複数の受光素子で得られる信号の強度バランスを調整していることを特徴としている。

【0012】特に、構成(1-1) 又は(1-2) において、(1-2-1) 前記スケール部は平行平面状の基板上に断面が台形状となるようにV溝を一定の周期で複数形成して構成されており、該台形状の平面部の幅と、該平面部を挟む2つの傾斜面の幅との比が変位情報を検出する変位方向と直交する方向で変化していること。

【0013】(1-2-2) 前記スケール部は円板上に断面が台形状となるV溝を径方向に沿って放射状に複数形成して構成されており、該台形状の平面部の幅と該平面部を挟む2つの傾斜面の幅との比が径方向に沿って変化していること。

【0014】(1-2-3) 前記スケール部は平板上に断面が台形状となるV溝を変位方向と直交する方向に複数形成して構成されており、該台形状の平面部の幅と該平面部を挟む2つの傾斜面の幅との比が変位方向と直交する方向で変化していること。

【0015】(1-2-4) 前記スケール部はプラスチックによるモールド成型より製造されたものであり、該モールド成型において、その場合の金型の加工を、種々の先端形状を有するバイトを該光学スケールの法線に対して平行に走らせ、バイト先端形状による溝部とそれ以外の部分との面積が同一でないこと。等を特徴としている。

【0016】

【発明の実施の形態】図1は本発明の実施形態1の要部概略図である。図中、1は光照射手段であり、例えばLEDから成っている。2は固定スケールであり、透明な円板上に白，黒パターンを放射状に又は放射状の光透過部2aと幅が一定の光遮光部2bとを形成しており、支持部材（不図示）に支持されている。3は可動の光学スケールであり、図2に示すように透明な円板（基板）3c上に一定周期の複数の格子3dを設けた構成より成り立っている。

【0017】格子3dは平坦部30aとV溝30bから成っている。固定スケール2はLED1からの光束を振幅分割して明暗のパターンを光学スケール3面上に投影している。光学スケール3は固定スケール2からの光束を3方向に波面分割（光変調）している。

【0018】4は受光手段であり、光学スケール3で光変調され射出した3つの光束を各々受光する為の3つのフォトディテクタ（受光素子）4a，4b，4cを有している。この受光手段4からの信号をパルスカウント回路や回転方向の判別回路を有する信号処理回路（不図示）等を用いて光学スケール3の、回転情報を得ている。

【0019】図2は図1の光学スケール3の要部概略図である。光学スケール3の格子部3dは内周から外周にかけて平坦部30aの幅が一定であり、V溝30bの傾斜面30b-1，30b-2の合計の周方向の幅は外周に行くにしたがい広くなっている。このようなV溝30bを有する光学スケール3をモールド成形する場合の金型の加工は、光学スケール3の法線に対して平行に台形バイトを走らせる。これは、バイトの走り方向が単純になるため加工が容易になり、溝の加工精度も高くなる。

【0020】図2(C)は図2(B)のA-A断面図，図2(D)は図2(B)のB-B断面図である。

【0021】本実施形態ではV溝30bの幅は外周にいくに従って広くなっている。この為図2(C)，(D)に示すように格子3dの平坦部30aの幅とV溝30bの傾斜部30b-1と30b-2との合計の幅との比は光学スケール3の回転中心から周辺にいくに従って変化

の一要素を構成している。3は位相差検出機能と振幅型の回折格子機能とを有する光学スケールであり、図2（B）に示すように円板状の基板3cの表面上に一定周期の複数の放射状格子（スリット数2500又は5000のV溝格子）より成る格子部3dを設けて構成している。

【0036】このとき格子部3dのうち平面部30aの幅は半径方向で同じであり、V溝の傾斜面30b-1，30b-2の合計の幅が半径方向で異なっている。この為格子部3dは平面部30aの幅に対する傾斜部30b-1，30b-2の合計の幅の比が半径方向で異なっている。

【0037】光学スケール3の基板3cは透孔性の光学材料、例えばポリカーボやプラスチックより成り、回転体（不図示）の一部に取り付けており、回転体と一体的に回転軸3eを中心に矢印16方向に回転している。

【0038】光学スケール3の格子部3dの詳細は図2（C），（D）で示すのと同様である。即ち、V溝部を構成する2つの傾斜面30b-1，30b-2と1つの平面部30aが交互に配列されて格子部3dを形成している。各々の傾斜面30b-1，30b-2はV溝の底部と中心とを結ぶ直線に対し各々臨界角以上で傾いている。

【0039】本実施形態では光学スケール3からの回折光のうち0次回折光と±1次回折光の3つの光束を利用している。ここで、この格子部3dのV溝は光学スケール3に対して放射状に構成されている為、光学スケール3の内周側と外周側ではピッチが異なっている。

【0040】尚、ここでピッチとは平坦部30aの幅と2つの傾斜面30b-1，30b-2の幅との合計した値を言う。

【0041】本実施形態では光学スケール3の材質をポリカーボやプラスチックとし、射出成形もしくは圧縮成形当の製法によって作成している。14は凹面ミラーであり、球面ミラー，楕円ミラー，放物ミラー，非球面ミラー等から成っている。凹面ミラー14は格子部3dのフーリエ変換面に一致している。

【0042】本実施形態ではレンズ系12で集光され、光学スケール3の第1領域3aに入射した光束101が光学スケール3の格子部で回折し、このときn次の回折光（0次と±1次の回折光）が凹面ミラー14の面14b又はその近傍（凹面ミラー14の瞳位置又はその近傍）に集光するように各要素を設定している。

【0043】凹面ミラー14の光軸14aと入射光束101の中心光線（主光線）は偏心している。凹面ミラー14は光学スケール3で回折し、集光してきた収束光束（3つの回折光束）を反射させ、光学スケール3面上の第2領域3bに3つの回折光に基づく干渉パターン像（像）を再結像させている。

【0044】このとき光学スケール3が回転方向16に移動すると再結像した像は回転方向16とは反対の方向に移動する。即ち、格子部と干渉パターン像は相対的に光学スケール3の移動量の2倍の値で相対変位する。

【0045】本実施形態ではこれにより光学スケール3に構成されている格子部の2倍の分解能の回転情報を得ている。

【0046】4は受光手段であり、光学スケール3の格子部3dの第2領域3b近傍に形成した干渉パターンと格子部のV溝との位相関係に基づく光束が第2領域3bで幾何学的に反射され、射出した3つの光束を各々受光する為の3つのフォトディテクタ（受光素子）4a，4b，4cを有している。この受光手段4からの信号をパルスカウント回路や回転方向の判別回路を有する信号処理回路103によって処理し、これより回転情報を得ている。尚、光源1，レンズ系12，そして受光手段4は筐体PK内に固定保持されている。

【0047】次に本実施形態における光学スケール（回転体）3の回転情報の検出方法について説明する。光照射手段の一要素であるLED1からの光束をレンズ系12により凹面ミラー面上14bの反射面4b又はその近傍に集光するようにしている。この収束光を光学スケール3の格子部3d上の第1領域3aに入射させる。第1領域3aに入射した収束光のうち図2（C），（D）に示す格子部3dの平面部30aに到達した光線は該平面部30aを通過して凹面ミラー14に進み、その面上に結像する。

【0048】またV溝を構成する傾斜面30b-1に到達した光線は、傾斜面30b-1の傾斜角が臨界角以上に設定されている為、図に示すように全反射してV溝を構成する他方の傾斜面30b-2に向けられ、傾斜面30b-2においても全反射する。

【0049】このように最終的に格子部3dの傾斜面30b-1へ到達した光線は、光学スケール3の内部に進入することなく、入射方向に戻されることになる。同様にV溝を構成する他方の傾斜面30b-2に到達した光線も全反射を繰り返して戻される。従って第1領域3aにおいてV溝を形成する2つの傾斜面30b-1，30b-2の範囲に到達する光束は、光学スケール3内に進入することなく反射され、平面部30aに到達した光線のみが光学スケール3を進むことになる。

【0050】即ち、第1領域3aにおいてV溝型の格子部3dは透過型の振幅回折格子と同様の光学作用を有する。この第1領域3aの格子部3dで光束は回折され、格子部の作用により0次，±1次，±2次…の回折光が生じ、凹面ミラー14の面上にその回折光が集光する。集光した回折光は、主光線に対して偏芯している凹面ミラー14によって反射し、光学スケール3の第2領域3b部で再結像し、光学スケール3面上に像（放射状の溝の像）を再結像する。

【0051】ここで第1領域3aと第2領域3bは光学

球面ミラー等から成っている。凹面ミラー14は格子部31dのフーリエ変換面に一致している。

【0068】本実施形態では図12に示すようにレンズ系12で集光され、光学スケール31の第1領域31aに入射した光束101が光学スケール31で回折し、このときn次の回折光（0次と±1次の回折光）が凹面ミラー14の面14b又はその近傍（凹面ミラー14の瞳位置又はその近傍）に集光するように各要素を設定している。

【0069】図13に示すように凹面ミラー14の光軸14aに対して入射光束101の主光線101aと凹面ミラー14で反射し、光学スケール31への再入射光束102の主光線102aは対称になっている。又、凹面ミラー14は光学スケール31から透過した収束光束（3つの回折光束）を反射させ、光学スケール31面上の第2領域31bに3つの像を再結像させている。このとき光学スケール31が矢印方向31eに移動すると再結像した像は矢印方向31eとは反対の方向に移動する。即ち、格子部と干渉パターン像は相対的に光学スケール31の移動量の2倍の値で相対変位する。

【0070】本実施形態ではこれにより光学スケール31に構成されている格子部の2倍の分解能の移動情報を得ている。

【0071】4は受光手段であり、光学スケール31の格子部31dの第2領域31b近傍に形成した干渉パターンと格子部のV溝との位相関係に基づく光束が第2領域31bで幾何学的に屈折され、射出した3つの光束を各々受光する為の3つのフォトディテクタ（受光素子）4a，4b，4cを有している。この受光手段4からの信号をパルスカウント回路や移動方向の判別回路を有する信号処理103によって処理し、これより移動情報を得ている。尚、光源1，レンズ系12，そして受光手段5は筐体PK内に固定保持されている。

【0072】次に本実施形態における光学スケール（移動体）31の移動情報の検出方法について説明する。光照射手段の一要素であるLED1からの光束をレンズ系12により凹面ミラー面上14の反射面14b又はその近傍に集光するようにしている。この収束光を光学スケール31の格子部31d上の第1領域31aに入射させる。第1領域31aに入射した収束光のうち図15に示す格子部31dの平面部31aに到達した光線は該平面部31aを通過して凹面ミラー14に進み、その面上に結像する。またV溝を構成する傾斜面31b－1に到達した光線は、傾斜面31b－1の傾斜角が臨界角以上に設定されている為、図に示すように全反射してV溝を構成する他方の傾斜面31b－2に向けられ、傾斜面31b　2においても全反射する。

【0073】これによって最終的に格子部31dの傾斜面31b－1へ到達した光線は、凹面ミラーに進入することなく、入射方向に戻されることになる。同様にV溝を構成する他方の傾斜面31b－2に到達した光線も全反射を繰り返して戻される。従って第1領域31aにおいてV溝を形成する2つの傾斜面31b－1，31b－2の範囲に到達する光束は、光学スケール31内に進入することなく反射され、平面部31aに到達した光線のみが光学スケール31を進むことになる。

【0074】即ち、第1領域31aにおいてV溝型の格子部31dは透過型の振幅回折格子と同様の光学作用を有する。この第1領域31aの格子部31dで光束は回折され、格子部の作用により0次，±1次，±2次……の回折光が生じ、凹面ミラー14の面上にその回折光が集光する。集光した回折光は、図13に示すように光軸14aに対して対称に反射し、光学スケール31の第2領域31b部で再結像し、光学スケール31面上に像を再結像させる。

【0075】ここで第1領域31aと第2領域31bは光学スケール31面の移動方向と直交する放射状格子の格子部31dに対して異なった（一部が重複していても良い）領域である。

【0076】本実施形態では、格子部31d上の第2領域31bに第1領域31aの格子部31dを投影するようにしている　そのために本実施形態では凹面ミラー14を所望の曲率半径Rに設定し、入射光束101の主光線101aと再入射光束102の主光線102aが光軸14aに対して対称となるようにしている。

【0077】これによって第1領域31aの格子部の像が凹面ミラー4によって第2領域31b面上に再結像するとき放射状格子の一部のピッチが合致するようにしてS／N比の良い検出信号を得ている。

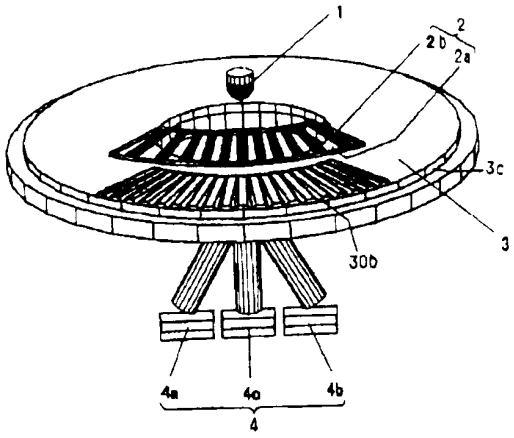
【0078】第2領域31bにおいて傾斜面31bに入射した光束は、図15（B）に示すように直線透過し、受光手段4の中央部のフォトディテクタ4cに到着する。また、V溝面を形成する2つの傾斜面31b－1及び31b－2に到達した光線は、各々の面に所定の入射角を持って入射するため、それぞれ異なる方向に大きく屈折して受光手段4の両側のフォトディテクタ5a及び5bに到達する。

【0079】このように第2領域31bにおいて、入射光束に対して異なる方向に傾斜した2つの傾斜面31b　1，31b－2及びV溝の間の平面部31aの合計3種の傾き方向の異なる面により、光束は3つの方向に別れて進み、各々の面に対応した位置に設けられた各フォトディテクタ4a，4b，4cに到達する。即ち第2領域31bにおいてV溝の格子部31dは光波波面分割素子として機能する。

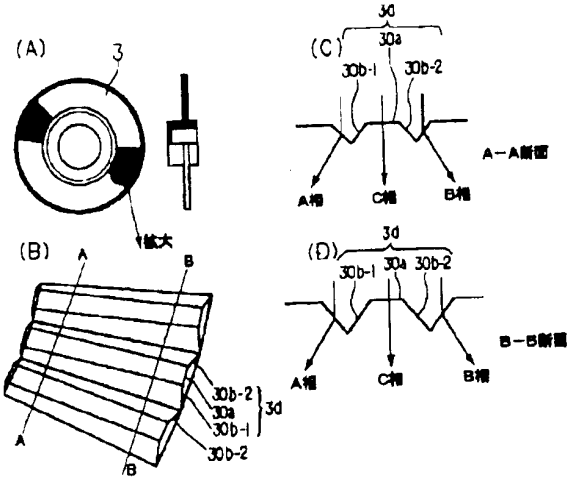
【0080】即ち第2領域31bの格子部と、その面上に結像した干渉パターン像との位相関係に基づく光束が3方向に偏向され、各フォトディテクタ4a，4b，4cに入射している。

【0081】ここで光学スケール31が移動すると、各

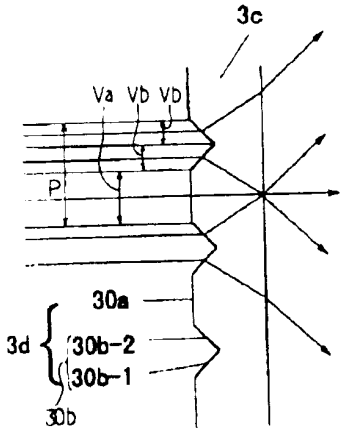
【図1】


1
2
2b
2a
3c
3
30b
4a
4c
4b
4

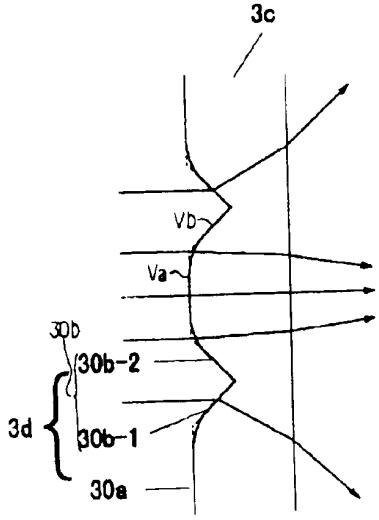
【図2】


(A)
3
拡大
(B)
A
B
30b-2
30a
30b-1
30b-2
3d
(C)
3d
30a
30b-1
30b-2
A-A断面
A相
C相
B相
(D)
3d
30b-1
30a
30b-2
B-B断面
A相
C相
B相

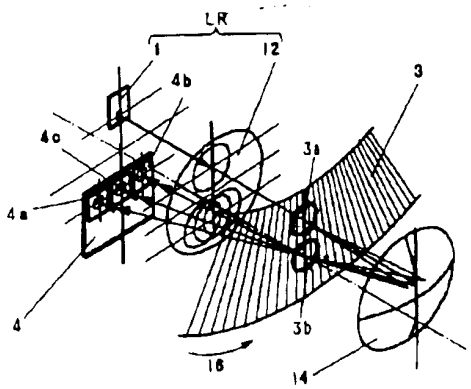
【図3】


3c
Va
Vb
Vb
P
30a
3d
30b-2
30b-1
30b

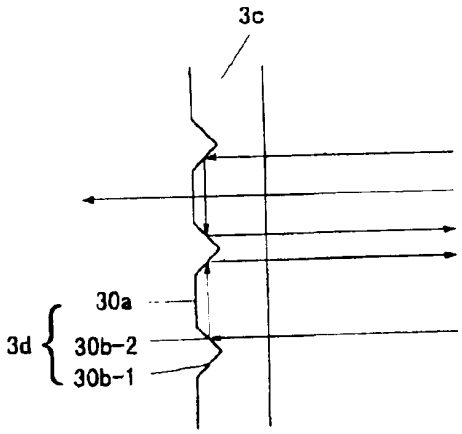
【図5】


3c
Vb
Va
30b
30b-2
3d
30b-1
30a

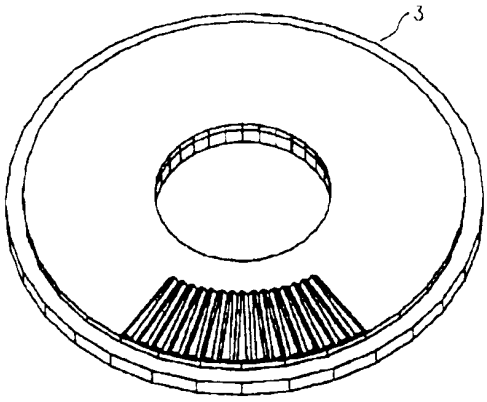
【図8】


LR
1
12
4b
4c
4a
4
3
3a
3b
16
14

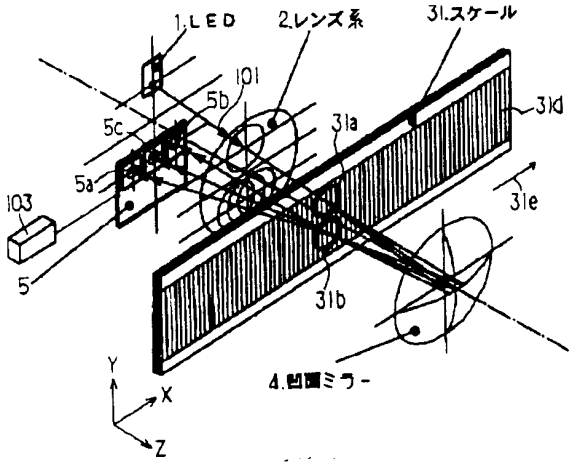
【図10】



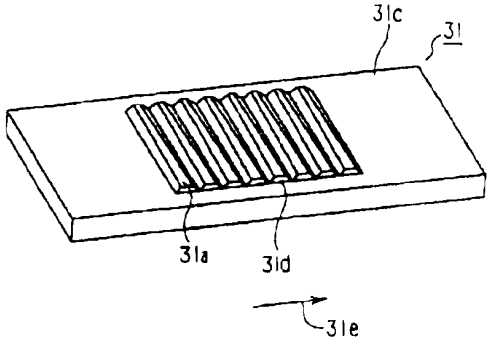
【図11】



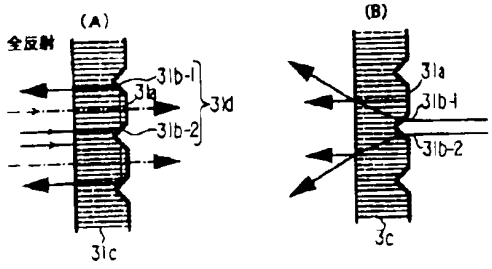
【図12】



【図14】



【図15】



フロントページの続き

(51)Int.Cl.⁶	識別記号	FI	
G01D 5/36		G01D 5/34	D

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 11-023324

(43)Date of publication of application : 29.01.1999

(51)Int.Cl. G01D 5/38
G01B 11/00
G01D 5/34
G01D 5/36

(21)Application number : 09-190518

(22)Date of filing : 30.06.1997

(71)Applicant : CANON INC

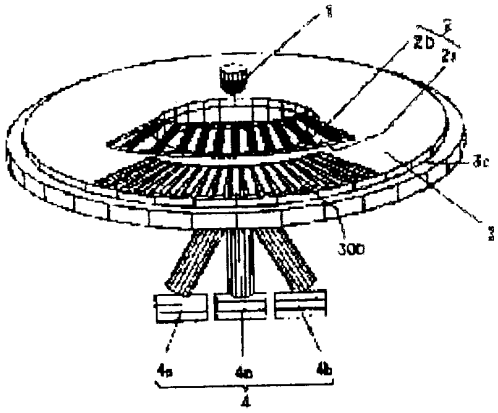
(72)Inventor : IGAKI MASAHIKO
TAKAYAMA MANABU

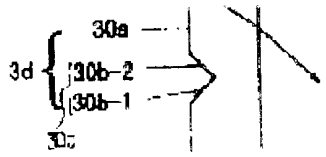
(54) APPARATUS FOR MEASURING DISPLACEMENT INFORMATION

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain highly accurate displacement information by moving a position of incidence of a luminous flux from a light-projecting means to an optical scale and adjusting an output signal level from a plurality of photodetecting elements.

SOLUTION: A luminous flux from a light-projecting means 1 enters a fixed scale 2 having an optical action of an amplitude diffraction grating, passes a transmission part 2a, projects bright fringes to a movable optical scale 3, enters a flat part 30a, penetrates linearly and reaches a photodetector 4c. Incident luminous fluxes to inclined faces 30b-1, 30b-2 having V groove faces are diffracted in different directions to reach photodetectors 4a, 4b. When the optical scale 3 rotates, the amount of light detected at each photodetector 4a-4c changes. That is, a balance of the amount of light entering the photodetector changes in accordance with a relative displacement of a position of a grating 3d and the fixed scale 2. A binary signal as a displacement signal is obtained on the basis of a set threshold from a signal corresponding to the balance change, so that highly accurate information of the movement of the optical scale 3 is obtained.





LEGAL STATUS

[Date of request for examination] 29.06.2001

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

CLAIMS

[Claim(s)]
[Claim 1] The scale section which carries out a wavelength split operation to at least one side among the 1st and the 2nd optical scale is prepared Incidence is carried out to the 1st and the 2nd optical scale one by one. the flux of light from an optical irradiation means -- this -- The flux of light divided into the plurality after minding the 1st and the 2nd optical scale is received with a light-receiving means to have the photo detector of an each plurality. this -- In an information measuring device the signal from this light-receiving means -- using -- this -- the relative variation rate with the 1st and the 2nd scale -- the variation rate which searches for an information -- an adjustment means -- the flux of light from this optical irradiation means -- this -- the variation rate characterized by adjusting the on-the-strength balance of the signal which changes the incidence position of a up to [the 1st and the 2nd optical scale side], and is acquired by two or more photo detectors of this light-receiving means -- an information measuring device
[Claim 2] The 1st field of an optical scale in which the scale section which carries out a wavelength split operation for the flux of light from the optical irradiation means established in the case was prepared is made to carry out incidence. Subsequently, make the 2nd field of this optical scale carry out re-incidence, and two or more flux of lights injected from this 2nd field are received with a light-receiving means to have two or more photo detectors respectively. In the displacement information measuring device which searches for the relative displacement information on this case and this optical scale using the signal from this light-receiving means The displacement information measuring device characterized by adjusting the on-the-strength balance of the signal which changes the incidence position of a up to [this optical scale side of the flux of light from this optical irradiation means], and is acquired by two or more photo detectors of this light-receiving means by the adjustment means.
[Claim 3] The aforementioned scale section is the claim 1 or the displacement information measuring device of 2 characterized by changing in the orientation which intersects perpendicularly with the displacement orientation where two or more V grooves are formed a fixed period, and it is constituted in so that a cross section may become trapezoid-like on an parallel flat-surface-like substrate, and the ratio of the width of face of the flat-surface section of the shape of this trapezoid and the width of face of two inclined planes which sandwich this flat-surface section detects a displacement information.
[Claim 4] The aforementioned scale section is the claim 1 or the displacement information measuring device of 2 characterized by the ratio with the width of face of two inclined planes which a cross section forms in a radial two or more V grooves which become trapezoid-like along the orientation of a path, is constituted, and sandwich the width of face of the flat-surface section and this flat-surface section of the shape of this trapezoid on a disk changing along the orientation of a path.
[Claim 5] The aforementioned scale section is the claim 1 or the displacement information measuring device of 2 characterized by changing in the orientation in which the displacement orientation and the ratio with the width of face of two inclined planes which a cross section forms two or more V grooves which become trapezoid-like in the orientation which intersects perpendicularly with the displacement orientation, is constituted, and sandwich the width of face of the flat-surface section and this flat-surface section of the shape of this trapezoid on monotonous cross at right angles.
[Claim 6] The aforementioned scale section is the displacement information measuring device of five given in any one term from the claim 1 to which it is manufactured from mould molding by plastics, the byte who has various nose of cam configurations for ****** of the metal mold of the slit section in that case is run in parallel to the normal of this optical scale in this mould molding, and area of Mizobe by the byte nose of cam configuration and the other fraction is characterized by not being the same

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention -- a variation rate -- an information measuring device -- being related -- especially -- a variation rate -- the wavefront-splitting operation generated when light is irradiated at a body (optical scale) -- using -- a variation rate -- variation rates, such as a rotation information on objective, and a move, -- suitable for a rotary encoder, a linear encoder, etc. which can calculate informational physical quantity with high precision

[0002]

[Description of the Prior Art] Photoelectricity-[former] the rotary encoder and linear encoder as business-machine machines, such as computer devices, such as a drive of a floppy disk, and a printer, or an NC machine tool, and a measurement means for detecting the amount of change of the rotational speed of rolling mechanisms, such as a ****** stainless steel motor of VTR and a rotating drum, or rotational speed or the amount of change of a straight-line move body further are used

[0003] Drawing 17 is an important section schematic diagram of the rotary encoder which sets up party rate level using the sum signal of the output signal from the light-receiving means which consists of three photo detectors proposed by JP,6-109484,A, and has acquired the rotation information.

[0004] The fixed scale with which arranged 81 by the light emitting device and 82 arranged a translucent part and the shading section in the fixed pitch in this drawing, and 83 are the movable scales which arranged the V groove the fixed period. The movable scale 83 is connected with the device-under-test field (un-illustrating). 84a, 84b, and 84c are photo detectors respectively.

[0005] As shown in drawing 3 , the width of face of two ramps Vb in which the width of face of the flat-surface section Va of a V groove forms 1/2 and the V groove to pitch P has the movable scale 83 1/4, and P respectively, and each ramp has the inclination of 45 degrees to the straight line which connects the perpendicular to the pars basilaris ossis occipitalis and the flat-surface section of a V groove.

[0006] the status that the predetermined phase contrast in photo detectors 84a, 84b, and 84c was given for the flux of light which passed the transparency section of the fixed scale 82, the flat-surface section Va of the V type slot of the movable scale 83, and the ramp Vb -- receiving light -- this -- using the signal from three photo detectors -- the variation rate of the device-under-test field -- orientation and a variation rate -- the amount etc. is detected

[0007] Even if the signal-processing technique of the signal acquired by three photo detectors 84a, 84b, and 84c at this time has change of the optical property by change of the photogenesis intensity of the flux of light from a light emitting device 81, the dirt of an optical scale, etc., the reliable binary-ized signal is made to acquire it. For example, party rate level is set up based on the sum signal of the output signal from three photo detectors 84a, 84b, and 84c, and the binary-ized signal has been acquired.

[0008]

[Problem(s) to be Solved by the Invention] Drawing 3 shows the case where the cross-section configuration of the V groove of a movable scale which has a V groove is ideal. However, the corner whose movable scale which generally has a V groove is the interface of the ramp Vb of a V groove and the flat part Va as shown, for example in drawing 5 from the problem of the imprint nature at the time of scale molding may become round. When such a scale was used, it is not detected by the predetermined ratio which needs the signal detected by three photo detectors in order to set up party rate level, but there was a problem that a reliable binary-ized signal could not be acquired.

[0009] this invention forms a V groove in a substrate side, and incidence of the flux of light is carried out to the optical scale which was made to carry out the wavefront splitting of the incoming beams from an optical irradiation means. Two or more flux of lights which carried out the wavefront splitting on this optical scale are respectively received by two or more photo detectors. In case a displacement information is searched for using the signal from two or more of these photo detectors, the variation rate of the incidence position to the optical scale of the flux of light from an optical

irradiation means is carried out. It aims at offer of the displacement information measuring device from which the binary-ized signal with a sufficient reliability is acquired, and a highly precise displacement information is acquired by adjusting the output signal level from two or more photo detectors

[0010]

[Means for Solving the Problem] Displacement information measuring device of this invention (1-1), the scale section which carries out a wavelength split operation to at least one side among the 1st and the 2nd optical scale is prepared Incidence is carried out to the 1st and the 2nd optical scale one by one. the flux of light from an optical irradiation means -- this -- The flux of light divided into the plurality after minding the 1st and the 2nd optical scale is received with a light-receiving means to have the photo detector of an each plurality. this -- In an information measuring device the signal from this light-receiving means -- using -- this -- the relative variation rate with the 1st and the 2nd scale -- the variation rate which searches for an information -- an adjustment means -- the flux of light from this optical irradiation means -- this -- it is characterized by adjusting the on-the-strength balance of the signal which changes the incidence position of a up to [the 1st and the 2nd optical scale side], and is acquired by two or more photo detectors of this light-receiving means

[0011] (1-2) Make the 1st field of an optical scale in which the scale section which carries out a wavelength split operation for the flux of light from the optical irradiation means established in the case was prepared carry out incidence. Subsequently, make the 2nd field of this optical scale carry out re-incidence, and two or more flux of lights injected from this 2nd field are received with a light-receiving means to have two or more photo detectors respectively In the displacement information measuring device which searches for the relative displacement information on this case and this optical scale using the signal from this light-receiving means It is characterized by adjusting the on-the-strength balance of the signal which changes the incidence position of a up to [this optical scale side of the flux of light from this optical irradiation means], and is acquired by two or more photo detectors of this light-receiving means by the adjustment means.

[0012] especially -- configuration (1-1) Or (1-2) It sets (1-2-1). Two or more V grooves are formed a fixed period, and the aforementioned scale section is constituted so that a cross section may become trapezoid-like on an parallel flat-surface-like substrate. with the width of face of the flat-surface section of the shape of this trapezoid Change in the orientation which intersects perpendicularly with the displacement orientation where the ratio with the width of face of two inclined planes which sandwich this flat-surface section detects a displacement information.

[0013] (1-2-2) The aforementioned scale section forms on a disk two or more V grooves which a cross section consists trapezoid-like of along the orientation of a path at a radial, and is constituted, and the ratio with the width of face of two inclined planes which sandwich the width of face of the flat-surface section and this flat-surface section of the shape of this trapezoid should be changing along the orientation of a path.

[0014] (1-2-3) The aforementioned scale section forms on monotonous two or more V grooves which a cross section consists trapezoid-like of in the orientation which intersects perpendicularly with the displacement orientation. is constituted, and change in the orientation in which the displacement orientation and the ratio with the width of face of two inclined planes which sandwich the width of face of the flat-surface section and this flat-surface section of the shape of this trapezoid cross at right angles.

[0015] (1-2-4) The aforementioned scale section is that the area of Mizobe according [are manufactured from mould molding by plastics, run in parallel the byte who has various nose of cam configurations for ****** of the metal mold of the slit section in that case to the normal of this optical scale in this mould molding, and] to a byte nose of cam configuration, and the other fraction is not the same. It is characterized by the grade.

[0016]

[Embodiments of the Invention] Drawing 1 is an important section schematic diagram of the operation gestalt 1 of this invention. Among drawing, one is an optical irradiation means, for example, consists of Light Emitting Diode. 2 -- a fixed scale -- it is -- a transparent disk top -- white and a black pattern -- a radial -- or light-transmission section 2a of a radial and optical shading section 2b with fixed width of face are formed, and it is supported by the support member (un-illustrating) 3 is a movable optical scale and is realized from the configuration which prepared 3d of two or more grids of a fixed period on transparent disk (substrate) 3c as shown in drawing 2.

[0017] 3d of grids consists of flat part 30a and V groove 30b. The fixed scale 2 carries out the amplitude splitting of the flux of light from Light Emitting Diode1, and has projected the pattern of light and darkness on the 3rd page of an optical scale. The optical scale 3 is carrying out the wavefront splitting (light modulation) of the flux of light from the fixed scale 2 in the three orientation.

[0018] 4 is a light-receiving means and has three photodetectors (photo detector) 4a, 4b, and 4c for receiving respectively the three flux of lights which light modulation is carried out and were injected on the optical scale 3. The rotation information on the optical scale 3 has been acquired using the digital disposal circuit (un-illustrating) which has a pulse-count circuit and the distinction circuit of a hand of cut for the signal from this light-receiving means 4.

[0019] Drawing 2 is an important section schematic diagram of the optical scale 3 of drawing 1 . 3d of the grid sections of the optical scale 3 is applied to a periphery from inner circumference. its width of face of flat part 30a is fixed, and the width of face of the hoop direction of inclined-plane 30b-1 of V groove 30b and the sum of 30b-2 is large as it goes to a periphery. ****** of the metal mold in the case of carrying out the mould molding of the optical scale 3 which has such V groove 30b runs a trapezoid byte in parallel to the normal of the optical scale 3. Since a byte's run orientation becomes simple. a manipulation becomes easy and. as for this, the process tolerance of a slot also becomes high

[0020] Drawing 2 (C) is an A-A cross section of drawing 2 (B), and drawing 2 (D) is a B-B cross section of drawing 2 (B).

[0021] With it, the width of face of V groove 30b is large as it goes to a periphery by this operation gestalt. As shown in view 2 (C) and (D) for this reason, the ratio with the width of face of the sum of the width of face of flat part 30a of 3d of grids, ramp 30b-1 of V groove 30b, and 30b-2 is changing as it goes on the outskirts from the center of rotation of the optical scale 3

[0022] Next, the method of detection of the rotation information on the optical scale 3 in this operation gestalt is explained. Incidence of the flux of light from Light Emitting Diode which is the optical irradiation means 1 is carried out to the fixed scale 2. The flux of light which penetrated transparency section 2a since this fixed scale 2 had the optical operation of an amplitude diffraction grating projects a bright fringe (pattern) on the movable optical scale 3. In the optical scale 3, as shown in drawing 3 , the straight-line transparency of the flux of light which penetrated bright pattern 2a and carried out incidence to flat part 30a is carried out, and it reaches photodetector 4c

[0023] Moreover, in order that the flux of light which carried out incidence to inclined-plane 30b-1 of 2 **s which penetrate bright pattern 2a and form a V groove side, and 30b-2 may have the incident angle of 45 degrees and may carry out incidence to each field, it is greatly refracted in the orientation different, respectively, and reaches each photodetectors 4a and 4b.

[0024] Thus, in the optical scale 3, the flux of light separates and progresses in the three orientation according to the field where the inclination orientation of a total of three sorts of flat-surface 30a between two inclined planes which inclined in the orientation different to incoming beams, 30b-1, 30b-2 and V groove 30b, and V groove 30b is different, and each photodetectors 4a, 4b, and 4c prepared in the position corresponding to each field are reached

[0025] That is, 3d of the grids which have V groove 30b in the optical scale 3 functions as a light wave region rate element. If the optical scale 3 rotates here, the quantity of light detected by each photodetectors 4a, 4b, and 4c will change. the position of 3d of grids and the position of the fixed scale 2 are relative -- supposing the quantity of light balance which carries out incidence to each photodetector changes according to a variation rate and the optical scale 3 rotates to anti-clock **** as a result, the quantity of light change accompanied by rotation of the optical scale 3 which is shown in drawing 4 (A) will be obtained

[0026] A quadrature axis is the rotation (variation rate amount deltaX) of the optical scale 3, and an axis of ordinate is the light-receiving quantity of light of a photodetector here. Signals a, b, and c correspond to photodetectors 4a, 4b, and 4c, respectively. Next, party rate level CL is set up by the digital disposal circuit, and the binary-ized signals Sa and Sb which are displacement signals as shown in drawing 4 (B) have been acquired from these three signals a, b, and c. The highly precise move information on the optical scale 3 has been acquired from this. At this time, the ratio of the quantity of light detected by photodetectors 4a, 4b, and 4c is 1:1:2, and has acquired the binary-ized signals Sa and Sb more reliable than this.

[0027] The signal shown in drawing 4 (A) and (B) is the case where 3d of the grids of the optical scale 3 is formed ideally. On the other hand, as the corner which is the boundary line of V groove 30b of the optical scale 3 and flat part 30a as shown in drawing 5 shows from the imprint nature of molding in drawing 5 , it may be roundish with a manufacture error etc., for example. In this case, the quantity of light which carries out incidence to three photodetectors 4a, 4b, and 4c becomes as it is shown in drawing 6 (A), and it separates from the ratio of the quantity of light detected by photodetectors 4a, 4b, and 4c greatly from 1:1:2.

[0028] At this time, compared with drawing 4 (B), pulse width precision differs greatly, and the binary-ized signals Sa and Sb cannot acquire an ideal signal precision. In order to make into the ratio of 1:1:2 always ideal the quantity of light detected by these three photodetectors 4a, 4b, and 4c Change the relative position of an optical irradiation means or the fixed scale 2, and the optical scale 3 by the adjustment means (un-illustrating), and the incidence position when carrying out incidence of the flux of light from the optical irradiation means 1 to the fixed scale 2 3, i.e., an optical scale, with this operation gestalt is moved in the orientation of a path. The balance of the quantity of light penetrated from V groove 30b and flat part 30a is adjusted.

[0029] next, the incidence position of a up to [the fixed scale 2 when carrying out incidence of the flux of light from the optical irradiation means 1 to the fixed scale 2 in this operation gestalt] -- how to adjust the quantity of light detected by photodetectors 4a, 4b, and 4c is explained

[0030] As shown in drawing 2 (B), in an inner circumference [of the optical scale 3], and periphery side, the ratios of

the width of face of V groove 30b and the width of face of flat part 30a differ, and the ratio of the quantity of lights a, b, and c detected by the photodetectors 4a, 4b, and 4c in the orientation of A-A of drawing 2 (B) and the orientation of B-B becomes as shown in drawing 7 (A) and (B)

[0031] Thus, by changing incoming beams in the orientation position of a path of the optical scale 3, the balance of the quantity of light detected by photodetectors 4a, 4b, and 4c is adjusted. For example, when the quantity of light ratio detected by photodetectors 4a, 4b, and 4c as shown in drawing 6 is not 1:1:2, the fixed scale 2 and the optical scale 3 are moved in the orientation of a path the ratio of the output quantity of light is adjusted, a quantity of light ratio is made to be set to 1:1:2, and, thereby, the reliable binary-ized signal has obtained

[0032] In addition, the variation rate of the any 1 orientation of a scale (2, 3) or the optical irradiation means 1, and the light-receiving means 4 is made to carry out in the orientation of a path in this operation gestalt. Moreover, the configuration of a fixed scale and an optical scale may be made reverse, the fixed scale 2 may be considered as the configuration which has a V groove, and the optical scale 3 may consist of an amplitude grating

[0033] Drawing 8 is an important section perspective diagram of a part of operation gestalt 2 of this invention, and drawing 9 is an important section cross section of a part of operation gestalt 2 of this invention. Compared with the operation gestalt 1 of drawing 1 , it differs in that the optical scale 3 acts in both a fixed scale and a movable scale, and has adopted the so-called self-projection method, and, as for this operation gestalt, other configurations are fundamentally the same

[0034] One in drawing is the light source, for example, is constituted from a Light Emitting Diode or semiconductor laser, and has emitted the coherency flux of light of wavelength lambda (632.8nm). 12 is a lens system, consists of a spherical lens or an aspheric lens, and is carrying out the light guide to the optical scale 3 which condenses and mentions the flux of light from the light source 1 later.

[0035] The light source 1, the lens system 12, etc. constitute an element of the optical irradiation means LR. the diffraction figure of syllogism of a phase contrast detection function and amplitude type [3] -- a cordless handset -- it is the optical scale which has ability, and as shown in drawing 2 (B), 3d of the grid sections which consist of two or more radial gratings (2500 slits or 5000 V groove grids) of a fixed period on the front face of disc-like substrate 3c is prepared and constituted

[0036] At this time, among 3d of the grid sections, the width of face of flat-surface section 30a is the same radial, and the width of face of inclined-plane 30b-1 of a V groove and the sum of 30b-2 differs by radial. For this reason, the ratios [as opposed to the width of face of flat-surface section 30a in 3d of the grid sections] of the width of face of the sum of ramp 30b-1 and 30b-2 differ by radial.

[0037] Substrate 3c of the optical scale 3 consists of plastics, the optical material, for example, the poly-carbo. of ******, is attached in a part of body of revolution (un-illustrating), and is rotating in the arrow head 16 orientation focusing on rotation-axis 3e in one with body of revolution.

[0038] The detail of 3d of the grid sections of the optical scale 3 is the same as drawing 2 (C) and (D) show. That is, two inclined-plane 30b-1, 30b-2, and one flat-surface section 30a which constitute V Mizobe are arranged by turns, and form 3d of the grid sections. Each inclined-plane 30b-1 and 30b-2 lean respectively to the straight line which connects the pars basilaris ossis occipitalis and center of a V groove above the critical angle.

[0039] With this operation gestalt, the three flux of lights of the zero-order diffracted light and primary [**] diffracted light are used among the diffracted lights from the optical scale 3. Here, since the V groove of 3d of this grid section is constituted by the radial to the optical scale 3, pitches differ in the inner circumference [of the optical scale 3], and periphery side.

[0040] In addition, a pitch means the total value of the width of face of flat part 30a, and two width of face, inclined-plane 30b-1 and 30b-2, here.

[0041] With this operation gestalt, the quality of the material of the optical scale 3 is made into a poly-carbo or plastics, and it is creating by injection molding or the process of a compression-molding this. 14 is a concave surface mirror and consists of the spherical-surface mirror, the ellipse mirror, the **** mirror, the aspheric surface mirror, etc. The concave surface mirror 14 is in agreement with the Fourier transformation side of 3d of the grid sections.

[0042] With this operation gestalt, it is condensed by the lens system 12 and the flux of light 101 which carried out incidence to 1st field 3a of the optical scale 3 diffracts in the grid section of the optical scale 3, and each element is set up so that the n-th diffracted light (zero-order and primary [**] diffracted light) may condense field 14b or near [its] (the concave surface mirror 14 near [a pupil position or near ' its]) the concave surface mirror 14 at this time.

[0043] Eccentricity of the main beam of light (chief ray) of optical-axis 14a of the concave surface mirror 14 and the incoming beams 101 is carried out. The concave surface mirror 14 is diffracted on the optical scale 3, the convergence flux of light (three diffraction flux of lights) which has condensed is reflected, and re-image formation of the interference pattern image (image) based on the three diffracted lights is carried out to 2nd field 3b on the 3rd page of an optical scale.

[0044] If the optical scale 3 moves to a hand of cut 16 at this time, the image which carried out re-image formation will move in the orientation where a hand of cut 16 is opposite That is, the relative displacement of the grid section and the interference pattern image is relatively carried out with movement magnitude twice the value of the optical scale 3.
[0045] The rotation information twice the resolution of the grid section constituted from this operation gestalt by the optical scale 3 by this has been acquired
[0046] 4 is a light-receiving means and has three photodetectors (photo detector) 4a, 4b, and 4c for receiving respectively the three flux of lights which the flux of light based on the phase relation between the interference pattern formed near the 2nd field 3b of 3d of the grid sections of the optical scale 3 and the V groove of the grid section was geometrically refracted by 2nd field 3b, and injected The signal from this light-receiving means 4 is processed by the digital disposal circuit 103 which has a pulse-count circuit and the distinction circuit of a hand of cut, and the rotation information has been acquired from this In addition, the fixed hold of the light source 1, the lens system 12, and the light-receiving means 4 is carried out into the case PK
[0047] Next, the method of detection of the rotation information on the optical scale (body of revolution) 3 in this operation gestalt is explained It is made to condense the flux of light from Light Emitting Diode1 which is an element of an optical irradiation means by the lens system 12 reflector 4b or near [its] the concave surface mirror side top 14b Incidence of this convergence light is carried out to 1st field 3a on 3d of the grid sections of the optical scale 3. The beam of light which reached flat-surface section 30a of 3d of the grid sections shown in view 2 (C) and (D) among the convergence light which carried out incidence to 1st field 3a passes this flat-surface section 30a, progresses to the concave surface mirror 14, and carries out image formation on the field.
[0048] Moreover, since the tilt angle of inclined-plane 30b-1 is set up more than the critical angle, the beam of light which reached inclined-plane 30b-1 which constitutes a V groove is turned to inclined-plane 30b-2 of another side which carries out total reflection and constitutes a V groove as shown in drawing, and carries out total reflection also in inclined-plane 30b-2.
[0049] Thus, the beam of light which finally reached to inclined-plane 30b-1 of 3d of the grid sections will be returned in the orientation of incidence, without advancing into the interior of the optical scale 3. The beam of light which reached inclined-plane 30b-2 of another side which constitutes a V groove similarly also repeats total reflection, and is returned. The flux of light which reaches two domains, inclined-plane 30b-1 and 30b-2, which follow and form a V groove in 1st field 3a will be reflected, without advancing into the optical scale 3, and only the beam of light which reached flat-surface section 30a will progress the optical scale 3.
[0050] the [namely,] -- in 1 field 3a, 3d of the V groove type grid sections has the same optical operation as a penetrated type amplitude diffraction grating The flux of light is diffracted in 3d of the grid sections of this 1st field 3a, and they are zero-order and the primary [**] order [2nd / **] by operation of the grid section... The diffracted light arises and the diffracted light condenses on the field of the concave surface mirror 14. It reflects by the concave surface mirror 14 which is ****ing to a chief ray, and re-image formation of the diffracted light which condensed is carried out in the 2nd field 3b section of the optical scale 3, and it carries out re-image formation of the image (image of the slot on the radial) on the 3rd page of an optical scale
[0051] 1st field 3a and 2nd field 3b are fields (the part may overlap) which are different in radial to 3d of the grid sections of the radial grating of the 3rd page of an optical scale here. At this time, as for 3d of the grid sections of the optical scale 3, the grid pitches of 1st field 3a and 2nd field 3b differ. Furthermore, also in the irradiation field of 2nd field 3b, the pitches by the side of the inner circumference of the optical scale 3 and a periphery differ.
[0052] Then, with this operation gestalt, expansion projection of the grid section of 1st field 3a is carried out, and it is made to form the same image (inversion image) as the pitch of 3d of the grid sections of the optical scale 3 in 2nd field 3b on 3d of the grid sections. Therefore, with this operation gestalt, it is set as radius-of-curvature R of a request of the concave surface mirror 14, and while arranging off center to the chief ray of incoming beams, the amount of gaps to an incident-light shaft is also made into the optimum value.
[0053] When the image of the grid section of 1st field 3a carries out re-image formation on 2nd field 3 the b-th page by the concave surface mirror 14 this, as the pitch of a part of radial grating agrees, the good detecting signal of an S/N ratio has been obtained
[0054] In this operation gestalt, it reflects by the concave surface mirror 14, and only the flux of light refracted geometrically is used in 3d of the grid sections this time among the three flux of lights which carried out re-image formation on 2nd field 3b of 3d of the grid sections
[0055] As 2nd field 3b is shown in drawing 10 , as shown in drawing, the straight-line transparency of the flux of light which carried out incidence to flat part 30a is carried out, and photodetector 4c of the center section of the light-receiving means 4 is reached. Moreover, in order to carry out incidence of the beam of light which reached two inclined-plane 30b-1 which forms a V groove side, and 30b-2 to each field with a predetermined incident angle, it is greatly refracted in the orientation different, respectively, and reaches the photodetectors 4a and 4b of the both sides of

the light-receiving means 4

[0056] In this way, the flux of light separates and progresses in the three orientation according to the field where the inclination orientation of a total of three sorts of flat-surface section 30a between two inclined-plane 30b-1, 30b-2, and the V grooves which inclined in the orientation which is different to incoming beams in 2nd field 3b is different, and each photodetectors 4a, 4b, and 4c prepared in the position corresponding to each field are reached. the [namely,] -- in 2 field 3b, 3d of the grid sections of a V groove functions as a light wave wavefront-splitting element

[0057] the [namely,] -- the flux of light based on the phase relation between the grid section of 2 field 3b and the interference pattern image which carried out image formation on the field is deflected in the three orientation, and is carrying out incidence to each photodetectors 4a, 4b, and 4c

[0058] If the optical scale 3 rotates here, the quantity of light detected by each photodetectors 4a, 4b, and 4c will change the position of 3d of the grid sections and the position of an image are relative -- supposing the quantity of light balance which carries out incidence to each photodetector changes according to a variation rate and the optical scale 3 rotates to anti-clock **** as a result, the quantity of light change accompanied by rotation of the optical scale 3 which is shown in drawing 4 (A) will be obtained A quadrature axis is the rotation of the optical scale 3, and an axis of ordinate is the light-receiving quantity of light here.

[0059] Signals a, b, and c correspond to photodetectors 4a, 4b, and 4c, respectively. In addition, when the optical scale 3 rotates to clock **** conversely, in photodetector 4b and signal b, photodetector 4a and signal c serve as [signal a] the output of photodetector 4c. Rotation informations, such as angle of rotation, the rotation or rotational speed of the optical scale 3, and a roll acceleration, have been acquired like the operation gestalt 1 on the basis of these signals.

[0060] Also in this operation gestalt, the incidence position of the orientation of a path to the optical scale 3 of the flux of light from the optical irradiation means 1 is adjusted with an adjustment means, the quantity of light ratio obtained by the photo detector 4 (4a, 4b, 4c) is adjusted, and the good signal of an S/N ratio has been acquired.

[0061] Drawing 11 is an important section schematic diagram of the optical scale concerning the operation gestalt 3 of this invention. The width of face of two ramps of a V groove is the orientation of a path, the optical scale 3 of this operation gestalt is equal, and the width of face of flat part 30a differs in the orientation of a path. That is, it has expanded one by one as the width of face of flat part 30a goes to the circumference section from a center. The operation as an optical scale is the same as that of the operation gestalt 1 and 2.

[0062] Drawing 12 is [explanatory drawing of a part of operation gestalt 4 of this invention and the drawing 14 of the important section perspective diagram of the operation gestalt 4 of this invention and the drawing 13] explanatory drawings of a part of operation gestalt 4 of this invention.

[0063] As for other basic configurations, it is only the same to differ in that this operation gestalt used the linear encoder instead of the rotary encoder of the operation gestalt 1 and 2 as a detection means of a displacement body, and the configuration of the optical scale 31 as a displacement body was changed in connection with it.

[0064] 31 in drawing is an optical scale, and it is fixed to the move body (un-illustrating), and it is moving in the orientation (variation rate orientation) shown in arrow head 31e. The optical scale 31 prepares and constitutes 31d of the grid sections which formed the V groove so that it might differ in the orientation in which the width of face of the inclined plane intersects perpendicularly with move orientation 31e on substrate 31c in the orientation which intersects perpendicularly with the move orientation, as shown in drawing 14. It differs in the orientation in which move orientation 31e and the width of face of flat-surface section 31a of 31d of the grid sections also cross at right angles. The optical scale 31 has the wavefront-splitting operation.

[0065] Drawing 15 (A) and (B) are the detail drawing of 31d of the grid sections of the optical scale 31, and two inclined-plane 31b-1, 31b-2, and one flat-surface section 31a which constitute straight-line-like V Mizobe are arranged by turns, and they form 31d of the grid sections. Each inclined-plane 31b-1 of a V groove and 31b-2 lean respectively to the pars basilaris ossis occipitalis of a V groove, and the perpendicular of flat part 30a above the critical angle.

[0066] With this operation gestalt, the three flux of lights of the zero-order diffracted light and primary [**] diffracted light are used among the diffracted lights from the optical scale 31. Here, the slot of 31d of this grid section is constituted in the shape of a straight line to the move orientation of the optical scale 31.

[0067] In addition, with this operation gestalt, the quality of the material of the optical scale 31 is made into a poly-carbo or plastics, and it is creating by injection molding or the process of a compression-molding this. 14 is a concave surface mirror and consists of the spherical-surface mirror, the ellipse mirror, the **** mirror, the aspheric surface mirror, etc. The concave surface mirror 14 is in agreement with the Fourier transformation side of 3d of the grid sections.

[0068] With this operation gestalt, as shown in drawing 12 , it is condensed by the lens system 12, the flux of light 101 which carried out incidence to 1st field 31a of the optical scale 31 diffracts on the optical scale 31, and each element is set up so that the n-th diffracted light (zero-order and primary [**] diffracted light) may condense field 14b or near [its] (the concave surface mirror 14 near [a pupil position or near its]) the concave surface mirror 14 at this time.

[0069] As shown in drawing 13 , it reflects to optical-axis 14a of the concave surface mirror 14 by chief ray 101a and the concave surface mirror 14 of incoming beams 101, and chief ray 102a of the re-incoming beams 102 to the optical scale 31 is symmetrical. Moreover, the concave surface mirror 14 reflects the convergence flux of light (three diffraction flux of lights) penetrated from the optical scale 31, and carries out re-image formation of the three images to 2nd field 31b on the 31st page of an optical scale. If the optical scale 31 moves to orientation of the arrow head 31e at this time, the image which carried out re-image formation will move in the orientation opposite to orientation of the arrow head 31e. That is, the relative displacement of the grid section and the interference pattern image is relatively carried out with movement magnitude twice the value of the optical scale 31

[0070] The move information twice the resolution of the grid section consituted from this operation gestalt by the optical scale 31 by this has been acquired

[007] 4 is a light-receiving means and has three photodetectors (photo detector) 4a, 4b, and 4c for receiving respectively the three flux of lights which the flux of light based on the phase relation between the interference pattern formed near the 2nd field 31b of 31d of the grid sections of the optical scale 31 and the V groove of the grid section was geometrically refracted by 2nd field 31b, and injected. The signal from this light-receiving means 4 is processed by the signal processing 103 which has a pulse-count circuit and the distinction circuit of the move orientation, and the move information has been acquired from this. In addition, the fixed hold of the light source 1, the lens system 12, and the light-receiving means 5 is carried out into the case PK.

[0072] Next, the method of detection of the move information on the optical scale (mobile) 31 in this operation gestalt is explained. It is made to condense the flux of light from Light Emitting Diode1 which is an element of an optical irradiation means by the lens system 12 reflector 14b or near [its] concave surface mirror side top 14. Incidence of this convergence light is carried out to 1st field 31a on 31d of the grid sections of the optical scale 31. The beam of light which reached flat-surface section 31a of 31d of the grid sections shown in view 15 among the convergence light which carried out incidence to 1st field 31a passes this flat-surface section 31a, progresses to the concave surface mirror 14, and carries out image formation on the field. Moreover, since the tilt angle of inclined-plane 31b-1 is set up more than the critical angle, the beam of light which reached inclined-plane 31b-1 which constitutes a V groove is turned to inclined-plane 31b-2 of another side which carries out total reflection and constitutes a V groove as shown in drawing. and carries out total reflection also in inclined-plane 31b-2

[0073] The beam of light which finally reached to inclined-plane 31b-1 of 31d of the grid sections by this will be returned in the orientation of incidence, without advancing into a concave surface mirror. The beam of light which reached inclined-plane 31b-2 of another side which constitutes a V groove similarly also repeats total reflection, and is returned. The flux of light which reaches two domains, inclined-plane 31b-1 and 31b-2, which follow and form a V groove in 1st field 31a will be reflected, without advancing into the optical scale 31, and only the beam of light which reached flat-surface section 31a will progress the optical scale 31.

[0074] the [namely,] -- in 1 field 31a, 31d of the V groove type grid sections has the same optical operation as a penetrated type amplitude diffraction grating The flux of light is diffracted in 31d of the grid sections of this 1st field 31a, and they are zero-order and the primary [**] order [2nd / **] by operation of the grid section.... The diffracted light arises and the diffracted light condenses on the field of the concave surface mirror 14. As shown in drawing 13 , it reflects symmetrically to optical-axis 14a, and re-image formation of the diffracted light which condensed is carried out in the 2nd field 31b section of the optical scale 31, and it carries out re-image formation of the image on the 31st page of an optical scale.

[0075] 1st field 31a and 2nd field 31b are fields (the part may overlap) different to 31d of the grid sections of the radial grating which intersects perpendicularly with the move orientation of the 31st page of an optical scale here

[0076] With this operation gestalt, it is made to project 31d of the grid sections of 1st field 31a on 2nd field 31b on 31d of the grid sections. Therefore, with this operation gestalt, it is set as radius-of-curvature R of a request of the concave surface mirror 14, and is made to be symmetrical [chief ray 101a of incoming beams 101, and chief ray 102a of the re-incoming beams 102] to optical-axis 14a.

[0077] When the image of the grid section of 1st field 31a carries out re-image formation on 2nd field 31 the b-th page by the concave surface mirror 4 this, as the pitch of a part of radial grating agrees, the good detecting signal of an S/N ratio has been obtained.

[0078] As shown in drawing 15 (B), the straight-line transparency of the flux of light which carried out incidence to inclined-plane 31b in 2nd field 31b is carried out, and it reaches photodetector 4c of the center section of the light-receiving means 4. Moreover, in order to carry out incidence of the beam of light which reached two inclined-plane 31b-1 which forms a V groove side, and 31b-2 to each field with a predetermined incident angle, it is greatly refracted in the orientation different, respectively, and reaches the photodetectors 5a and 5b of the both sides of the light-receiving means 4.

[0079] In this way, the flux of light separates and progresses in the three orientation according to the field where the

inclination orientation of a total of three sorts of flat-surface section 31a between two inclined-plane 31b-1, 31b-2, and the V grooves which inclined in the orientation which is different to incoming beams in 2nd field 31b is different, and each photodetectors 4a, 4b, and 4c prepared in the position corresponding to each field are reached. the [namely,] -- in 2 field 31b, 31d of the grid sections of a V groove functions as a light wave wavefront-splitting element

[0080] the [namely,] -- the flux of light based on the phase relation between the grid section of 2 field 31b and the interference pattern image which carried out image formation on the field is deflected in the three orientation, and is carrying out incidence to each photodetectors 4a, 4b, and 4c

[0081] If the optical scale 31 moves here, the quantity of light detected by each photodetectors 4a, 4b, and 4c will change. the position of 31d of the grid sections and the position of an image are relative -- supposing the quantity of light balance which carries out incidence to each photodetector changes according to a variation rate and the optical scale 31 moves in the orientation of move orientation 31e as a result, the quantity of light change accompanied by a move of the optical scale 31 which is shown in drawing 4 (A) and (B) will be obtained

[0082] The move information on the optical scale 31 has been acquired like the operation gestalt 1 by this. The quantity of light ratio which adjusts the incidence position to the orientation which intersects perpendicularly with move orientation 31e to the optical scale 31 top of the flux of light from the optical irradiation means 1 also in this operation gestalt, and is obtained by the photo detector 4 (4a, 4b, 4c) is adjusted, and the good signal of an S/N ratio has been acquired. A quadrature axis is the movement magnitude of the optical scale 3, and an axis of ordinate is the light-receiving quantity of light here.

[0083] In addition, you may use a trapezoid slot which is shown in drawing 16 instead of the V groove prepared on a substrate in each above operation gestalt.

[0084] The flux of light which passed flat part 30a, ramp 30b-1, and 30b-2 in this drawing is carrying out incidence to photo detectors 4c, 4a, and 4b respectively.

[0085] Moreover, as operation gestalt of this invention as shown in drawing 18 , the configuration of changing discontinuously along the orientation of a path is sufficient as flat part 30a, ramp 30b-1, and 30b-2.

[0086]

[Effect of the Invention] According to this invention, as mentioned above, form a V groove in a substrate side and incidence of the flux of light is carried out to the optical scale which was made to carry out the wavefront splitting of the incoming beams from an optical irradiation means. Two or more flux of lights which carried out the wavefront splitting on this optical scale are respectively received by two or more photo detectors. In case a displacement information is searched for using the signal from two or more of these photo detectors, the variation rate of the incidence position to the optical scale of the flux of light from an optical irradiation means is carried out. The displacement information measuring device from which the binary-ized signal with a sufficient reliability is acquired, and a highly precise displacement information is acquired can be attained by adjusting the output signal level from two or more photo detectors.

[0087] Especially according to this invention, it is 3 by the imprint nature of an optical scale. Adjustment of a quantity of light balance is attained by making the position where the ratio of a V groove and a flat part is different carry out incidence of the flux of light, even when the quantity of light balance obtained with the light-receiving means of ** cannot satisfy a ratio called ideal 1:1:2. Reliable 2 A value-ized signal can be acquired and the displacement information measuring device which can detect the displacement information on a mobile with high precision can be attained.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The important section schematic diagram of the operation gestalt 1 of this invention
[Drawing 2] Explanatory drawing of a part of drawing 1
[Drawing 3] Explanatory drawing of a part of drawing 1
[Drawing 4] The output signal and binary-ized signal-description view from the light-receiving means of drawing 1
[Drawing 5] Explanatory drawing of the optical scale with the V groove
[Drawing 6] Explanatory drawing of the output signal from the light-receiving means when using the optical scale of drawing 5
[Drawing 7] Explanatory drawing of the output signal from the light-receiving means by the adjustment means in the operation gestalt 1 of this invention
[Drawing 8] The important section schematic diagram of the operation gestalt 2 of this invention
[Drawing 9] The important section cross section of the operation gestalt 2 of this invention
[Drawing 10] Explanatory drawing of a part of drawing 8
[Drawing 11] Explanatory drawing of the optical scale concerning the operation gestalt 3 of this invention
[Drawing 12] The important section schematic diagram of the operation gestalt 4 of this invention
[Drawing 13] Explanatory drawing of a part of drawing 12
[Drawing 14] Explanatory drawing of a part of drawing 12
[Drawing 15] Explanatory drawing of a part of drawing 12
[Drawing 16] Explanatory drawing of the optical scale concerning this invention
[Drawing 17] The important section schematic diagram of the conventional rotary encoder
[Drawing 18] The important section perspective diagram of other operation gestalt of the optical scale concerning this invention
[Description of Notations]
1 Optical Irradiation Means
2 Fixed Scale
3, 31 Movable scale (optical scale)
4 Light-receiving Means
4a, 4b, 4c Photo detector
30b V groove
30a Flat-surface section
30b-1, 30b-2 Ramp
12 Lens System
14 Concave Mirror
103 Digital Disposal Circuit

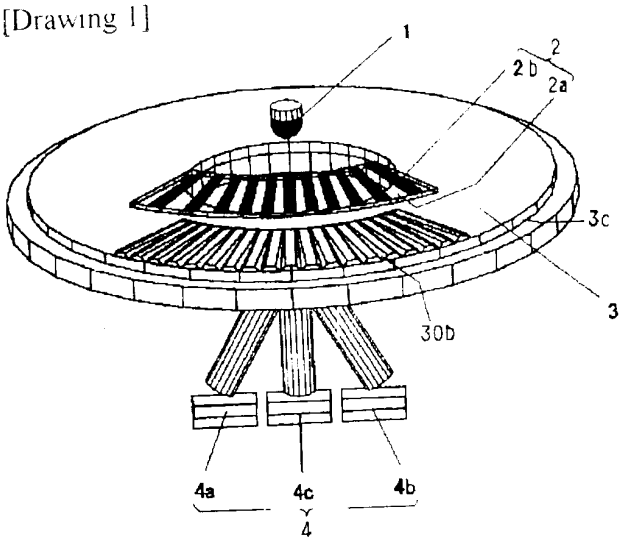
[Translation done.]

* NOTICES *

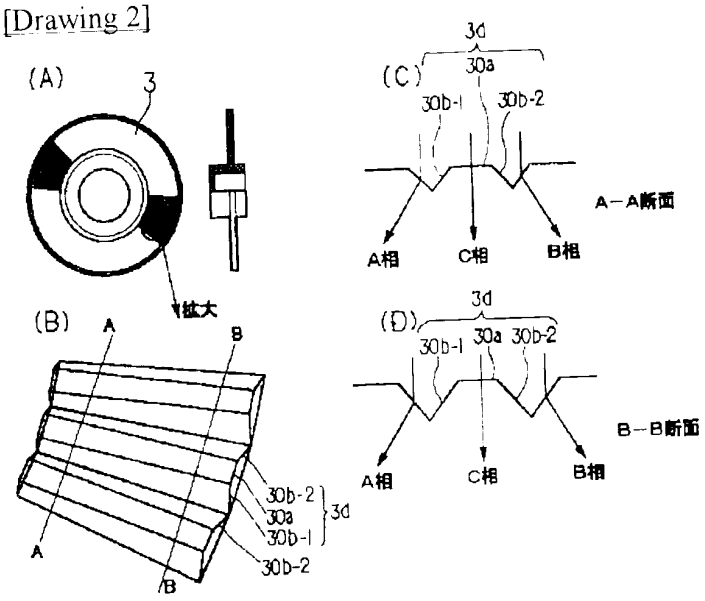
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

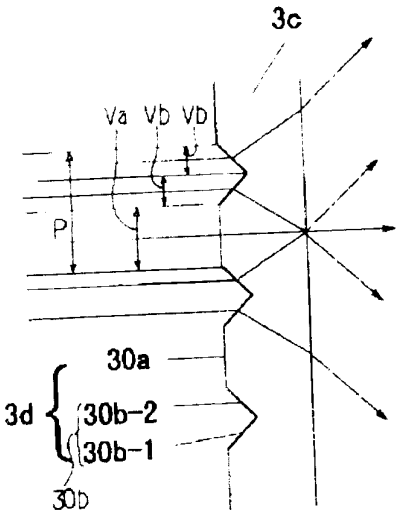
[Drawing 1]



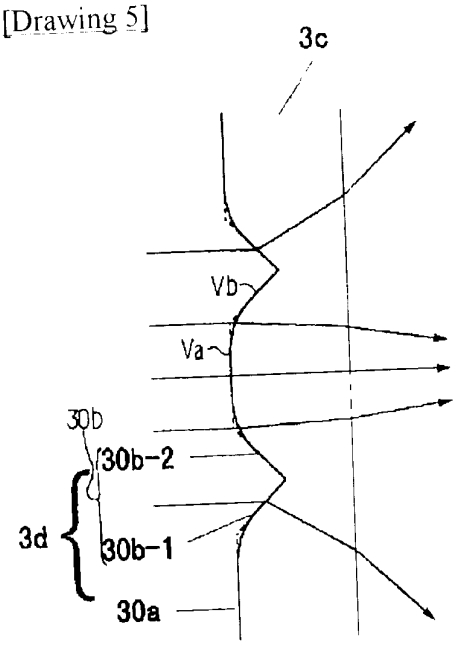
[Drawing 2]



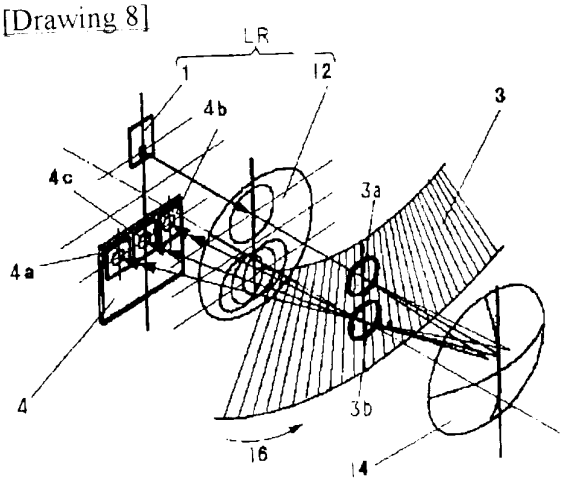
[Drawing 3]



[Drawing 5]

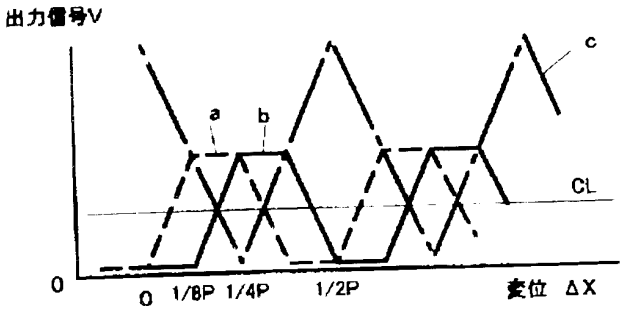


[Drawing 8]

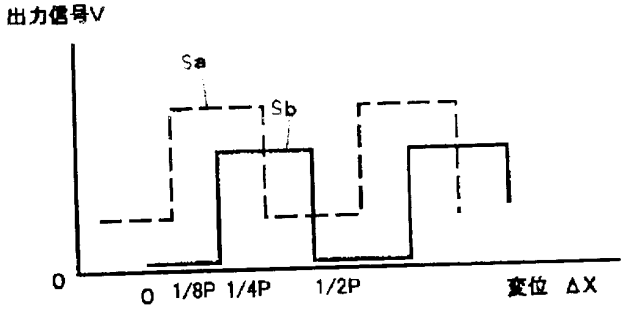


[Drawing 4]

(A)

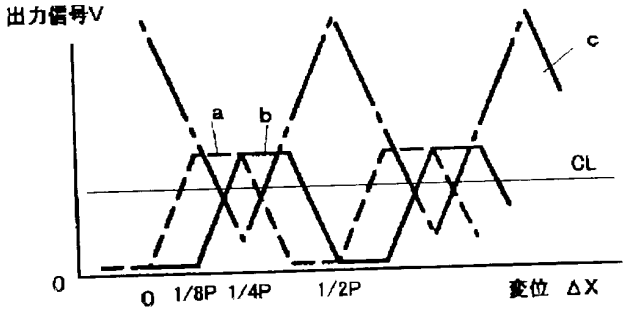


(B)

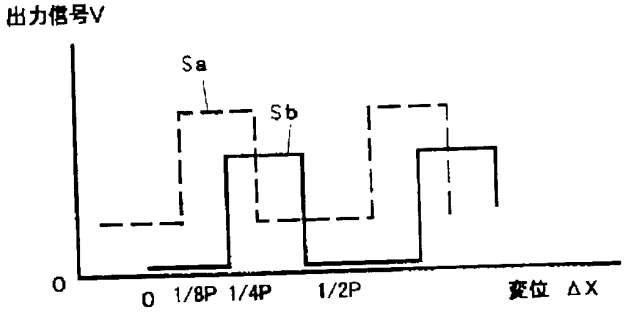


[Drawing 6]

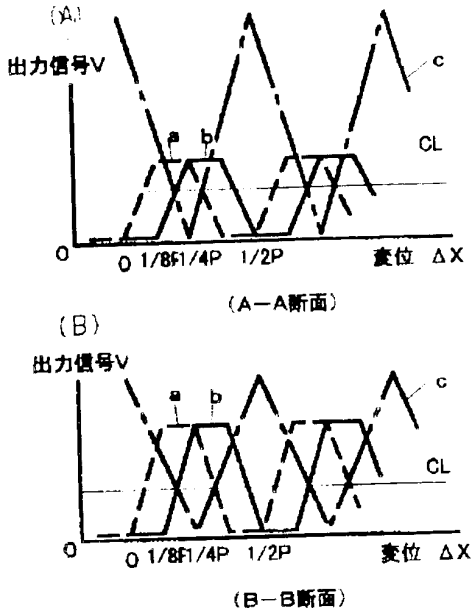
(A)



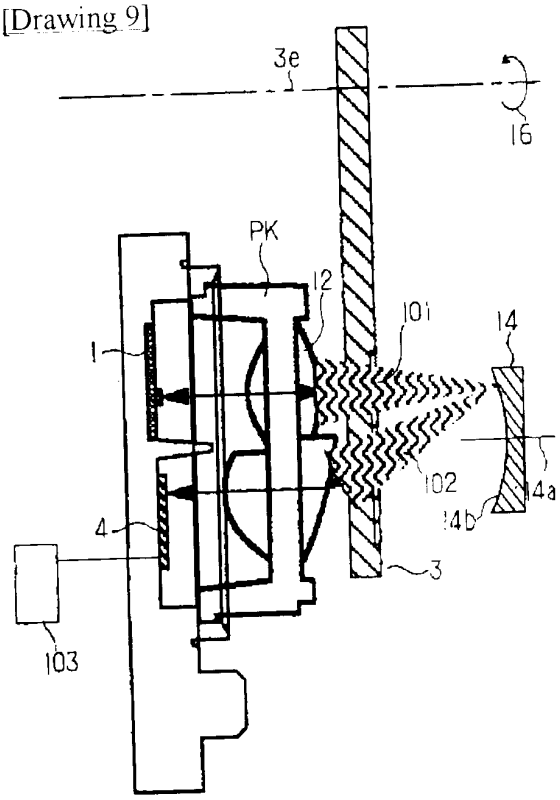
(B)



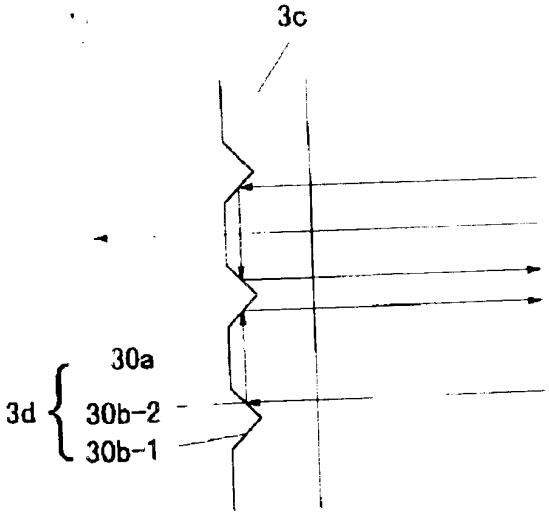
[Drawing 7]



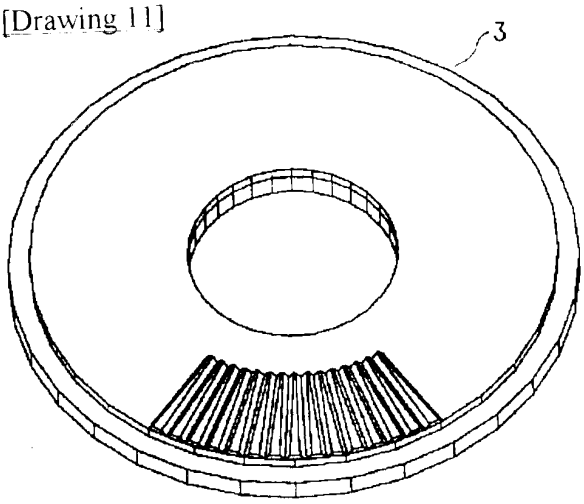
[Drawing 9]



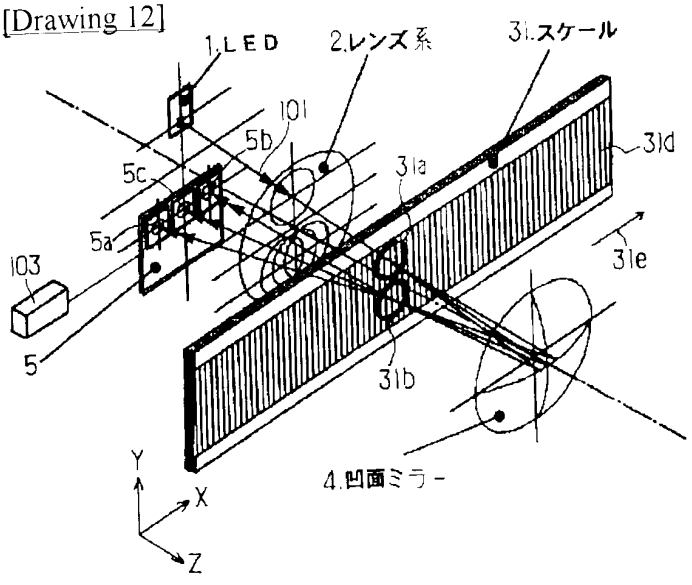
[Drawing 10]



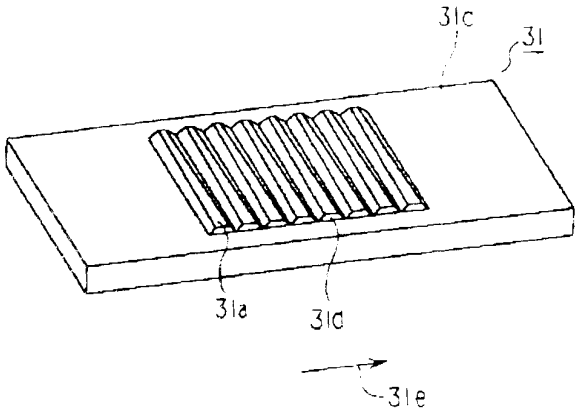
[Drawing 11]



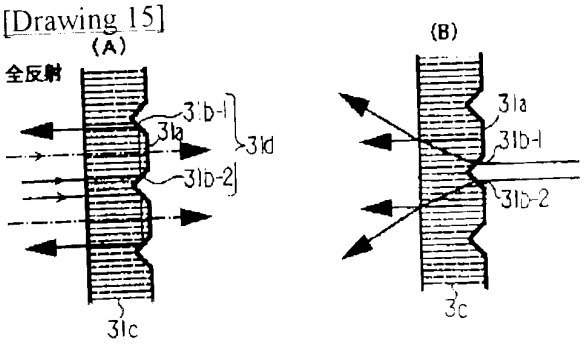
[Drawing 12]



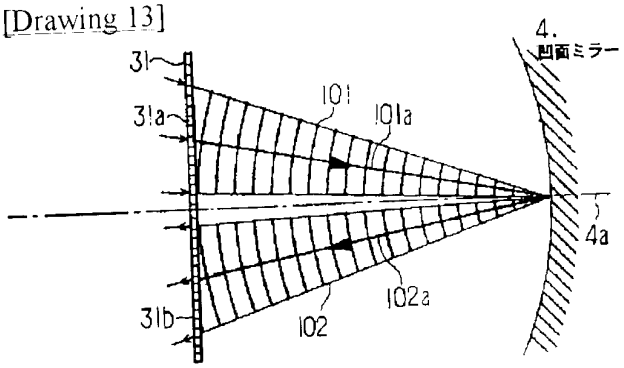
[Drawing 14]



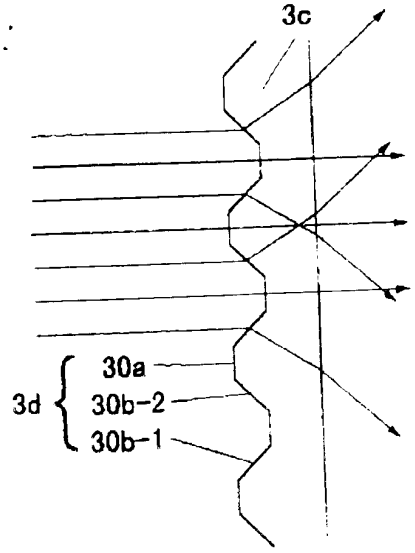
[Drawing 15]



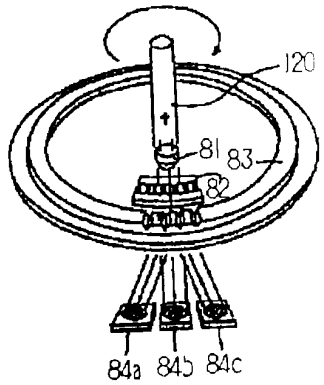
[Drawing 13]



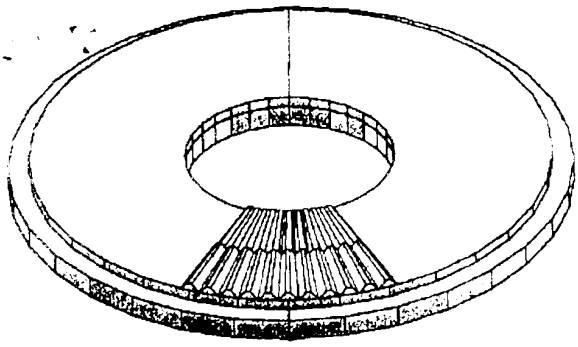
[Drawing 16]



[Drawing 17]



[Drawing 18]



[Translation done.]